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CRITICISMS AND DISCUSSIONS.

A SATIRE ON THE PRINCIPLE OF RELATIVITY.

EDITORIAL INTRODUCTION.

The principle of relativity has been advanced by two physicists, Dr. Albert Einstein, of Zurich, and H. A. Lorentz of Leyden; and by a mathematician, Hermann Minkowski of Göttingen. The two former are still living, but unfortunately Professor Minkowski has died prematurely. Their theories have found much recognition and the number of their admirers in the scientific world of to-day is legion.

The results of the new view are most astounding. The traditional conceptions of science are abolished and the new doctrine that replaces them is so paradoxical as to justify the boldest dreams of the superrational and superscientific fancies of savage and medieval mysticism. The public stand in breathless astonishment and the man of common sense is baffled.

This new movement has been discussed editorially in several articles in *The Monist*,¹ which have recently been collected in book form under the title *The Principle of Relativity in the Light of the Philosophy of Science*, and in these a rather critical attitude is taken toward the bold conclusions which the new school draws from what seems to us a neglect of a proper recognition of the principle of relativity. The present number of *The Monist* contains an article by Professor More of Cincinnati University which criticizes certain details of the theories of the leading relativists, taking them of course quite seriously. But there has now appeared on the scene a Vienna engineer, one Mr. Leo Gilbert, a satirist who pours upon the heads of the inventors of the new physics,

¹ "The Principle of Relativity," April, 1912; "The Philosophy of Relativity," October, 1912; "The Principle of Relativity as a Phase in the Development of Science," July, 1913.

and also upon their most prominent supporters, the vials of his sarcasm in a book which bears the vigorous title *Das Relativitätsprinzip, die jüngste Modenarrheit der Wissenschaft*.² He dedicates the book to Mr. Rudolf Goldscheid, joint editor with Prof. Wilhelm Ostwald of the *Monistische Jahrhundert*.

The irony which pervades this little book is certainly of sufficient interest to justify extended extracts which will prove both instructive and amusing. The advocates of the new principle of relativity will say that our author harps too much on the same string, viz., the paradox of inverting time, allowing the future to precede the present and even the past and thereby rendering it possible that an effect may precede its cause. We will even grant that he does not, at least in this book before us, try to do full justice to the intentions of his adversaries; but a satirist has the privilege of a poet and we need not take him over-seriously. Even a greater man than Leo Gilbert, the Attic playwright Aristophanes, plied the whip on the wrong man, on Socrates, when he meant the then modern school of Sophists, the relativists and pragmatists of decadent Athens. So we must forgive Mr. Gilbert for sometimes being too severe, and also for sometimes hitting too hard. The book is thus described in

THE PUBLISHERS' ANNOUNCEMENT.

In the last seven years the principle of relativity has found wide circulation and has gained many adherents. Nevertheless many have also been puzzled by the strange logical contradictions of this new theory which make heavy demands upon their credulity. Philosophers, as in fact all educated people, are perplexed by the fact that absolutely new views of the nature of time are introduced and all previous habits of thought seem to be overthrown. At the same time it must not be forgotten that such new principles are always thought out only by the few and that the majority must be reconciled either against their will or submissively to the views which are thrust upon them by these few. Confident opponents of the principle dare not venture forth, for they are at once repulsed, overwhelmed with scorn or otherwise subjected to unpleasant experiences. But when an entirely new cosmogony is to be constructed then its opponents must be heard first, since they contribute most

² Verlag Dr. W. Breitenbach at Brackwede i. W., Germany. The extracts quoted in this review have been translated for *The Monist* by Lydia G. Robinson.

of all to the clarification of the new system of ideas. Therefore an author should be gratefully received who has found the extraordinary courage and love of work carefully to weigh this miracle-working hypothesis of the "relativity of time" and to publish his opposition in a satirical form which is universally intelligible and at the same time affords entertainment. As Leo Gilbert himself says, it grieved him exceedingly that he was compelled to a satirical treatment of the matter by the indolence of the specialists and their skill in killing by silence. In his preceding work on "The Foundations of Exact Science" (*Fundamente des exakten Wissens*), he had shown that it is the seriously constructive, positive work in science which he has at heart. Even in this satire he has not been driven so much towards negation as toward positive results, for the most noticeable thing in his satirical treatment is the fundamental reality which led him to the solution of a problem that has been hanging in the balance for sixty years, namely the Fizeau experiment. Hence we must say that the entertaining form in which Leo Gilbert's polemic is carried on, while providing an important explanation of the doubtful aspects of the principle of relativity, at the same time affords captivating reading—though naturally only in so far as the reader is not too zealous an adherent of the principle of relativity prone to condemn in advance every other view as heretical. However one may feel about the book, in any case it is an interesting document of an intellectual movement and a scientific controversy of our own day.

THE MEANING OF RELATIVITY.

[Leo Gilbert thus complains that relativists neglect to define the term:]

These investigators have neglected first to determine what they wish to understand by "relativity." They have used the innocent word blindly, regardless of consequences. The designation of the new "principle of relativity," which contains not the slightest trace of "relativity," has arisen in the same way. Foolish misuse of words!...

It is an ancient and atrocious evil of science that it uses the same word interchangeably in the most different meanings. Since the mind must each time bring order anew into this chaos, mental operations become difficult and many errors arise. It thus becomes a strict requirement of the economy of thought that these gentlemen should define relativity before they apply it. Nevertheless I can

inform them right now that such a definition is rather difficult and troublesome, for in every relative there lurks an absolute, and in every absolute a relative. Thus in the relativity of Newton, the absolute appears in the guise of the specific zero of the relative. For instance, if only one of the velocities b , d , and e equals zero the absolute values of all the others are at once known to us. Thus, if the sun had the velocity $b=0$ in space, then the absolute velocities of all our planets would be known. Here I find another fundamental error from which the relativists proceed and which throws light upon their remarkable philosophical comprehension. They think, as Schames expresses it, that nature must remain "faithful" to itself everywhere; but these gentlemen mean by this that nature must remain faithful in every case to their own lack of intelligence.

The fact is they believe that everything, even time itself, must be made relative in the sense of the relativity of space. These scholars have no suspicion that the world and the knowledge of the world rest upon contrasts, that there is an absolute for every relative. If science designates certain features of space as relativity it must still strive to determine (1) what are the limitations of this relativity, (2) where it passes into its opposite, (3) what we must regard as its counterpart, its correlate, the absolute. Doubtless space and time are opposed to each other as the infinitely great arch-integral to the infinitely small arch-differential, as the boundlessly extended to the exactly limited, as the constantly being to the disappearing functional, as the relative to the absolute....

The greatest mistake of the gentlemen is that they ignore a self-evident fact in order to discover a monstrosity.

NEWTON TURNS IN HIS GRAVE.

[The author begins his satire with the following introduction:]

Lately I dreamed of meeting the immortal Newton. "How do you come here?" I asked in astonishment. He answered:

"I am an old gentleman, over two centuries old and quite stiff and lazy; so I would not have thought it possible that I could turn over in my grave with such lightning rapidity, but it gave me a dreadful shock when Professor Sommerfeld of Munich recently declared at a learned congress that the fabulous new principle of relativity of Messrs. Lorentz, Einstein and Minkowski had been well established for six years. I decided to come back to earth at once and find out what was the matter, and how these over-zealous people had supplemented my old theory of relativity by

a wonderful new abracadabra charm. My spirit glided with youthful agility into the body of a professor who is in the habit of looking down upon his colleagues in a high and mighty way. Then I betook myself to a number of famous old scholars of the highest rank who kept outside the crowd, hoping that I might find out something from them. But here I was no less astonished. These geniuses, like all the neutral professors, privat-docents, young freshlings and mathematical dillettantes, all gave me one and the same answer. Whenever I attacked the fiction, its sponsor would defend the 'new ideas' like a lion. He would quote formulas, roots, velocities of light, experiments of Fizeau, Michelson, Morley for perhaps ten minutes at a stretch. Then right in the heat of the debate he would grow strangely lukewarm, would become lame in the hips and finally creep off into an impenetrable thicket of brambles, saying: 'Oh I have not been able to enter into the matter in such detail, I only tell what I have read. But still there seems to be something deep in it; that may be taken for granted. Just think of the Kantian ideality of space and time and how it is again confirmed here!' Hardly would the lion have uttered the word 'Kant,' of whose meaning of course he had barely the remotest suspicion, when he would again become a ravenous beast in his safe bramble thicket snarling at me and showing his teeth."

"What the Devil's the use of being 'specialists,'" cried Newton greatly excited, "when they have 'only read,' when they have not even taken the trouble to study carefully these wonderfully fascinating 'problems' and 'new discoveries'? Why are they blind believers in miracles, idly boasting of Kant's ideality without knowing what it is? And yet they pretend to be men of exact science! Are they not ashamed of their intellectual beggary and vagueness?"

When I awoke and the master had disappeared, I reflected upon my dream and thought of the many friends who apply to me, mostly philosophers and naturalists who are "not mathematicians," people who in their guileless honesty believe that the sacred image of Sais is hidden behind the tomfoolery of formulas in whose brambles the originators of the "new principle" are hopelessly lost. They ask: "Can you not explain to me what there really is in it? It must be very magnificent!" Now, my dear inquiring friends, I will tell you!

TWISTED LOGIC.

The logic with which these gentlemen treat science will be best illumined by the mental lightning which Professor Einstein permits to flash on us only "incidentally," quite aside from the other fundamental attainments of his nimble intellect. He carries out a calculation with his formulas of relativity and goes on to say:³ "This result signifies that we must regard as possible a transmissive mechanism by means of which the anticipated effect precedes the cause (perhaps accompanied by an act of will). Although in my opinion this result in a purely logical sense contains no contradiction, nevertheless it is so absolutely opposed to the character of our entire experience that through it..."

Isn't that great! The very top notch of freedom from prejudice! According to Professor Einstein no logical contradiction is involved when the effect takes place *before* the cause, hence when, so to speak, the effect acts as the cause of the cause, in which case then the cause would appear as the effect of the effect. How droll! And why not? Let us illustrate: The farmer's wife finds an egg in the stable. In a week she will go to market and buy the hen that is to lay the egg she has already found. Who can object to this? Einstein agrees with it.

An oak has been cut down; a chauffeur and three passengers of an auto lie with broken heads by the side of the road. Afterwards, however, it occurs to the chauffeur to put on the highest speed and rush against the oak, lose his presence of mind and let go the steering wheel. The coroner of course held the inquest over the four bodies two weeks before the accident, and three years previously they were buried—the effect before the cause.

We also admire the education attained by a good old man whose parents are only just born—all of which Professor Einstein would find quite "natural."

These are the same gentlemen who have been so busily and fashionably engaged with entropy, and who when it comes to the point, do not even know that their "entropy" means that every occurrence has a direction in time.

These gentlemen fire before they load, post up laws of nature before they discover them and place knowledge in their head when

³ In the *Annalen der Physik*, edited by Wien and Planck, Leipsic, 1907, Vol. XXIII, pp. 381-382, in the article "On the Inertia of Energy Demanded by the Principle of Relativity."

they have no head. Nothing is impossible for the true scholar—*den echten Gelehrten, den verkehrten, unerhörten, überquerten, reingelehrten—quasi geistesgestörten.*

Einstein may be a distinguished scholar in the matter of figures and formulas, but when it comes to the philosophy of nature and the theory of cognition he is without any doubt an eminently useless man, a genius of illogic. And the rest are no better.

Equally wonderful is Prof. H. A. Lorentz's theory of electricity. According to his view matter consists of matter—of course worthless dead matter—but with electrons added to it. Nature takes electrons and attaches them to simple motionless matter. ("Synthetikon glues, sticks, cements everything: one tube only twenty pfennigs!") Now if we tickle both matter and electrons, matter alone will suffer it patiently. The electrons however become excited, and then they are electrical. On the other hand, if matter is given a velocity it no longer remains indifferent; it straightway changes the unchangeable, its mass! For a long time Lorentz proposed that it only changed its length, but then other insisted that it changed its mass. In the world of "these" physicists who are also called "new," everything is conceivable. Where guns kill before they go off and go off before they are loaded, "mass" can easily be sweated out through the pores of matter. This is not at all surprising in a physics according to which the electrons break their way, or "stream," through a massive copper wire with a velocity of 300,000 kilometers.

Why? How? By what means do electrons cling to matter? What is the use of matter if it is inactive? What is the deeper connection, the real significance of these things? What is the sense of "mass" if mass be changeable and if it can disappear? How can the law of conservation suddenly be surrendered? What after all is the meaning of this "new" physics which denotes an absurdity radically lacking in system, a ridiculous tomfoolery?

What is mass after all?

Just consider the grand unitary world-conception, so actual, so sensible, so beautiful and unbroken which the grand old thinkers have built up, men like Faraday, Hertz, Mach, Ernst Haeckel and others, and compare with it this crazy, giddy, confused whimsicality. It presses the wine before the grapes ripen and cuts the grapes before they are grown; before men drink they stagger and reel in drunkenness and folly.

HOLES IN THE ETHER.

Every year about ten thousand professors of high schools, universities, technical institutes, and also some independent scholars devise about ten thousand queer hypotheses of which they themselves are the only fanatical adherents.

Perhaps ten or twenty of them find a dozen blindly faithful believers among their boon companions at the tavern. One will whisper to another with lifted brows: "O that Bookmiller, he has a head on him! The world will hear from him yet. He has proved positively that if a camel be only large enough it can go through the eye of a needle! He has proved it by higher mathematics!"

Higher mathematics! That chokes off every contradiction! A few out of the hundreds of thousands are more successful. They find believers by the help of a high-sounding name. This was the case a hundred years ago with phlogiston, and fifty years ago with the world's entropy-end and with countless other jokes. Such is the case to-day with the "new" principle of relativity. According to it the largest camels have actually passed through the tiniest needle's eye of this principle. It is the eternal victory of banality operating with "higher mathematics"....

Poincaré, whose calling as a mathematician is not attacked here, in his lecture on "The New Mechanics" arrives at this remarkable decision: "We can almost say that there is no longer matter but only holes in the ether, and in so far as these holes seem to play an active part it consists in the inability of these holes to change their location without influencing the surrounding ether which exerts a reactive influence on such changes."

This entire statement is fabulous, yea insane, and might pass in a sanitarium for incurables. Fabulous is the typical academic caution with which the famous mathematician expresses himself. He does not say, "Thus it is and not otherwise." He only says, "We may *almost* say." Nothing rises up within him against the paradox that holes play an "active" part. He does not perceive in the least that just this thing we can not say, not even "almost." He expresses himself very cautiously with professorial diplomacy: "in so far as these holes 'seem' to play an active part." What genuinely scholarly delicacy: "seem"! We can assure M. Poincaré with absolute certainty that this time appearances are most lamen-

tably deceptive; that holes can disclose no activity; that they lack all fitness to evoke any sort of "reaction." We could assure M. Poincaré, the famous mathematician, (if he were still alive) that by holes is understood the opposite of anything that can parade as energy or as capacity for work. By "holes" the human intellect has always understood and will continue to understand the unsubstantial, the unenergetic....

When certain gentlemen speak of "nature philosophy" they remind me of the Italian "nature singers," who certainly do not understand singing and do not even possess voices; but that is exactly what they call nature.

THE ELEMENT OF MYSTERY IN THE "NEW RELATIVITY."

First of all we shall try to make the nature of this "fact" comprehensible to the popular mind by a comparison.

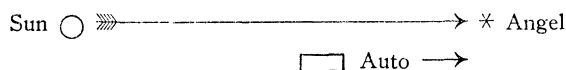


Fig. 1.

Let us imagine an angel flying away from the sun with the velocity of $c = 300,000$ kilometers per second. If we stand on the sun we can observe that the angel is moving away from us a distance of 300,000 kilometers every second. This is his velocity with reference to us as inhabitants of the sun.

Let us now place a chauffeur in an automobile which starts from the sun at the same time and rushes along by the side of the angel with a velocity of $a = 299,999$ kilometers. Then the angel will gain only one kilometer over the auto in a second. The angel moves away from the chauffeur only one kilometer each second. Hence with respect to the chauffeur the angel possesses a velocity of only one kilometer per second. This is clear and positive.

Now what would we think of a man who came along and said: "No that is not right. Instead, the fact is that there continues to be a difference of velocity of 300,000 kilometers between the angel and the auto. No matter what the velocity of the auto, the angel precedes it always 300,000 kilometers more every second; for instance 3,000,000 kilometers in ten seconds. In other words, no matter how rapidly the chauffeur may be moving, the velocity of the angel with reference to him is exactly as great as it is for the stationary inhabitants of the sun." Would we not judge that such a

man was not quite normal in the upper story, or think with Goethe that

"A contradiction absolute
Is always for the wise, no less than fools, a mystery"?

A COMMON-SENSE EXPLANATION OF THE PRINCIPLE.

Before we enter upon a critique of the principle of relativity, we shall here present in brief outlines what it really signifies. It treats of the motion of bodies in space, and of the velocity of transmission of rays of light. And indeed we observe the motion of bodies which travel equal distances in equal times and which therefore possess so-called "translatory" velocity. We assume with the relativists that the ray of light is transmitted in an absolutely stationary medium, in cosmic ether or in empty space, hence independently of the motion of any kind of body.

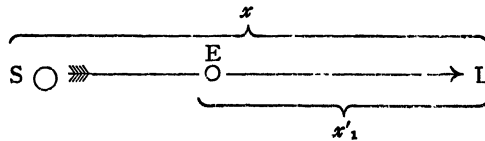


Fig. 2.

At first glance the matter seems supremely simple. Let S represent the sun. Let $S \rightarrow \rightarrow \rightarrow L$ be a ray of light that travels through empty space with a velocity of $c = 300,000$ kilometers per second. Let E be the earth which, as we arbitrarily assume, moves with a velocity of $a = 100,000$ kilometers in the direction of the arrow. Every one can now say: If we stand on the earth and measure the velocity of the ray of light it is only $E \rightarrow \rightarrow L = c - a = 300,000 - 100,000 = 200,000$ kilometers ahead of the earth at the end of one second. In other words, the more rapidly the earth moves, the smaller is the difference between the two velocities. If the earth were to dash through the universe as rapidly as the ray of light, then the latter would possess no difference in velocity with reference to the earth; i. e., they would both arrive at the same time. The ray of light would possess a velocity of 0 with reference to the earth. This is what would be expected clearly and unequivocally from the standpoint of common sense. But this is the point where the relativists violate logic and replace the sensible conclusion by a very different one. They say: Whatever may be the velocity a of the earth, the ray of light will always outdistance it by $c =$

300,000 kilometers. If the earth stands still the ray of light will have a velocity of 300,000 kilometers measured from the earth. But if the earth moves at the rate of 100,000 kilometers still the light ray will exceed it every second at the rate of 300,000 kilometers. This is Einstein's famous "principle of the constant velocity of light."

The reader sees at once that this last assertion is impossible. Its conclusion is contradictory to logic if, as above assumed, we accept the hypothesis of the relativists according to which a ray of light is entirely independent and is supposed to move independently in an ideally conceived empty, absolutely stationary cosmic space. In this space the ray of light could have a velocity only $c - a = 200,000$ kilometers greater than that of the earth. Hence the view of the relativists contains a fallacy. They would have the relative velocity of light with respect to the earth $c - a = c$, however great a may be, and this is an impossibility. On the basis of their hypothesis, $c - a = c$ can only be true when $a = 0$; i. e., if the earth remained as motionless as the sun. How the relativists come to their remarkable claim will be discussed elsewhere. Here we will merely mention briefly that they lean upon an experiment made by Michelson and Morley. From this they think they may deduce that the ray of light always possesses the same velocity of transmission of 300,000 kilometers with respect to the earth, no matter with what velocity and in what direction the earth may move.

This conclusion they call "the fact" which is identical with their "principle of the constancy of the velocity of light." Upon this "fact" they erect the principle of relativity. The principle of the constant velocity of light may be expressed very generally as follows:

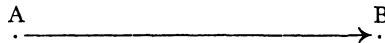


Fig. 3.

Let A be a body from which a ray of light proceeds and B another body which receives the light, e. g., a mirror or the eye of an observer. Then this principle will mean that the velocity of transmission of light with respect to A and also to B always possesses the same value c no matter what the velocity of each of these bodies.

THE MICHELSON EXPERIMENT.

Whenever one speaks about the principle of relativity to serious estimable people, minds of the first rank, they reply: "To be sure I haven't dug into this principle very deeply as yet, but there must be something in it. There is a fact at the bottom of this principle. Michelson has performed an experiment that..."

Fact? My head swims! Have we then come to this after a century of exact research that we talk about "facts" like bad lawyers? Some bewigged head peeps through a telescope and sees a black elephant whirling around between Jupiter and Saturn. Hence it is a "fact" that black elephants fly back and forth between the planets! What! Do you doubt it? Still, it is a fact! Professor Valerian Eyeblicker saw it himself in the observatory! Unobjectionable!

What is the real fact about this "fact"? Only that Mr. Valerian has seen something black! Whether it is an elephant, or whether it moved among the constellations, or whether it was a fly in the telescope, or a *mouche volante* in his own eye, is no longer a fact but the interpretation of a fact.

Of course there are no "facts" but only phenomena and their interpretation. For instance it has always been a "fact" that the earth turned around its axis and around the sun, but for thousands of years the phenomenon was given the interpretation that at night the sun slipped under the earth in a stove-pipe and hid there until it came out again in the morning to wander across the firmament. When Galilei and Kepler found other interpretations people would not believe at first that they were right. For thousands of years every one had been able to see the sun rise in the morning, even children; it was a "fact." And yet it was not a fact. Then what is a fact?

To the relativists the ray of light constitutes an object of "fact." Since by its nature this is just as unknown as the angels of religious myths, anything can be invented about it that one wishes.

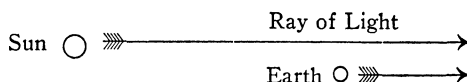


Fig. 4.

Hence, a ray of light moves away from the sun at the rate of 300,000 kilometers a second. According to the statement of the

astronomers the earth possesses a velocity with respect to the sun of barely 30 kilometers a second, hence $\frac{1}{10000}$ of that of light. If the relativists' hypothesis is correct, that the ray moves independently in a stationary vacuous cosmic space, then we must regard the velocity of light with respect to the earth in the direction of the earth's motion as $c - a = 299,970$. In the direction perpendicular to this there would be no subtraction. The ray would retain its $c = 300,000$ kilometers per second. Therefore it must be confirmed practically by experiment whether a ray of light in the direction of the earth's motion shows a lesser velocity than a ray perpendicular to this direction.

Michelson has performed a corresponding experiment with a ray from a lamp and has found that a ray of light in the direction of the earth's motion by no means remains 30 kilometers behind a ray perpendicular to this direction, but that both rays travel equal distances in equal times. . . .

Thus the result of Michelson's experiment is—as Hertz has long surmised—very simple and a matter of course. The ray of light depends only on the atmosphere through which it moves. It is an undulation of the atmosphere.

THE FOUR RELATIVIST POSTULATES.

An intelligent and versatile author, Herr Fritz Müller, published an excellent popular presentation of the principle of relativity entitled "Der Zeitgeist," in the *Berliner Tageblatt* of October 16, 1911, following upon a lecture of Professor Einstein in Zurich. In order to facilitate the reader's insight into this subject, we here quote his expositions. The comments do not come from Herr Müller but originate with the present author.

A short time ago Professor Einstein gave a lecture on the relativity of time before the society of naturalists in Zurich. When he had finished, a wave of excitement passed over the learned heads. A fallacy had been pointed out, a fallacy as old as humanity itself. For hundreds of thousands of years the apparent experiences of our organs have deceived us into thinking that there is an absolute time in cosmic space. Both the child and the critical scholar believed it, but the assertion is false. Einstein, on the basis of the preliminary studies of other physicists, has corrected it and found that there is no such thing as absolute time. Time is dependent on motion in space.

I know that at first sight this statement does not arouse interest.

It leaves the layman as cool to-day, as did the discovery that the earth turned around the sun, and not the sun around the earth, in Galilei's time. Galilei was an intellectual revolutionist when he exposed an optical illusion and deduced the inexorable consequences which created anew for mankind the image of the universe. Einstein exposed a fallacy in the conception of time, and what are the consequences as regards our world-conception? Here they are:

1. There is no rigid time. Time shrinks together with motion in space.
2. There are no rigid bodies. Their forms flow with motion in space.
3. Space and time are interchangeable.
4. There is no ether.

The principle of relativity is decisive for these remarkable results. What is relativity? The fact that there is nothing absolute in the universe. Every condition depends upon another. Taken mentally, philosophically, this has been clear to us for a long time.... That velocity in space and that time as the content of consciousness are relative is a truism, but the physicist stretches his notion of the term "relative" still farther.

VELOCITY EATS TIME.

Suppose two clocks keeping the same time to have each an observer and to stand side by side. Now suppose one of them with its observer suddenly rushes out into space with the velocity of light. The two observers have previously agreed to telegraph the time every second by means of a light signal. Men have no other medium but light by which to communicate with each other about the simultaneousness of two occurrences in different places. Further let us bear in mind that the criterion of simultaneousness is that the passage of the ray of light should take as long in one direction as in the other. Is this the case with the two clocks when they stand side by side? Obviously yes. And if one clock is traveling with the velocity of light? Obviously no; for the stationary observer, it is true, receives at regular intervals of one second the stipulated light signal from the other, but the latter does not receive any from the former. Whenever the stationary observer wishes to signal his time to the moving observer—whether in a fraction of a second after the start, or one, two or three seconds after—he is never able to do so, and the other one waits in vain for a signal. The signal behind the moving observer will never, never in all

eternity, overtake him if he travel with the same velocity as the signal itself. Hence the criterion is wrong. After one, after two, after three seconds the clocks would show a difference of one, two or three seconds. But in the judgment of the stationary observer this would indicate that the moving clock would be just that much too slow. In our extreme case in which the journey is made with the swiftness of light the stationary observer would believe that the other clock would not arrive in time at all; that there time would stand still. The Einstein equations actually arrive at this result. The same is true, Einstein says, of the observer traveling with the clock, namely, that in the opinion of the stationary one he would never grow old. "And what if he return to his point of departure on a broken line?" somebody asked the lecturer in the discussion. "Then in our judgment he would remain as young as when he started," answered Einstein in all seriousness, "even if we who remain behind had in the meantime become gray-haired; the equations furnish for every direction of motion, even for motion in a broken line, the same results without variation." We look at each other. That sounds fabulous. Fabulous? Certainly, the old fables of the monk of Heisterbach, of Rip van Winkle, of Urashima Taro come to our minds. It is strange how popular imagination has taken the same direction with the Germans, the Americans and the Japanese—all three tales concern people whose life stands still for many years, while those around them age. Thus at their return they find another land and a different generation.

"And if we imagine," another one objects, "that there was some sort of an effect which could be transmitted along a cord, we will say, with a velocity greater than that of light?" "Then it would have to be possible," answered the lecturer, "to devise a mechanism by means of which an effect could be produced upon the past." "And the result would be?" "Merely that this idea is so contrary to our experience that we are compelled to reject it until the opposite is proved. Hence we must assume on the basis of our previous experience that a velocity exceeding that of light is impossible, that it is absurd." Again the hearers are reminded of something, this time it is the remarkable novel *The Time Machine* by the Englishman Wells, who a dozen years ago made his engineer hero construct a machine by means of which he could set himself back into the past. In a remarkable anticipation of future research that poet speaks of time as of a fourth dimension which is of equal validity with our ordinary three dimensions of space, indeed is

even interchangeable with them. Nevertheless the mathematician Minkowski, building upon Einstein's foundation, comes also to the conclusion that physical occurrences are represented in a four-dimensional space in which time plays the same rôle as the three physical dimensions. Further Minkowski concludes: "From this hour space-in-itself and time-in-itself are to disappear entirely into shadows and only a sort of union of the two will retain independence, for no one has observed a place except at some time, or a time except in some place." And time? It may be entirely or partly replaced, extinguished by motion. That which we call time will be wholly compensated by a motion which proceeds with the velocity of light. A body traveling in space with the velocity of light will, from our point of view, be forever timeless. Hence, space is time and time is space. To put it strongly, motion eats time.

[A strange proposition! If a motion equals the velocity of light which is our means of communicating the time of a distant clock to us, time disappears and so we learn that velocity eats the time. Time is annihilated.]

TIME OVERTAKEN BY VELOCITY.

Let us consider a case which may also be found in somewhat altered form in the work of Camille Flammarion.

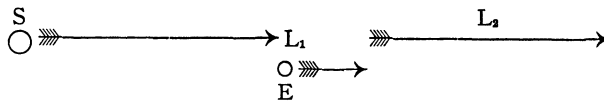


Fig. 5.

Let us imagine the earth *E* traveling before the sun with a velocity greater than that of light. Then the rays *L₁* which come afterwards will never reach it but will always be farther and farther behind. We shall not see the sun any more at our left. But yesterday and the day before yesterday, and many hundred years before that, rays *L₂* have been emanating from the sun which have already proceeded far ahead in cosmic space. The earth now travels into this ocean of rays and catches up with all of them in succession, since it of course travels faster than a ray. What will happen now? Our eyes will be pierced successively by the rays of light which the sun sent forth yesterday, ten years ago, one hundred years ago. Hence we will obtain pictures from the sun's past in earlier and earlier years, will observe its life and

development inversely, will witness the sun-child as boy, as baby, as an infant in swaddling clothes, until the sun is decomposed into the rotating masses of vapor from which it has originated. We would witness the entire process of the sun's growth in an inverse direction....

Our eyes travel with the earth along the rays L_2 . Hence these rays reach our retina from the right and we shall no longer see the sun on our left, for in that direction it has disappeared from our view. From this time we shall perceive its reflection only from the right, accordingly in the direction opposite to that in which it really is....

These mystifications, these optical illusions in the observation of things were known to us long before the relativists. The relativists attempted merely to adopt this idea, but they have corrupted it instead by dragging their formulas into it, in consequence of which the visions here described count for them as "facts." In the case just described, in which according to the old conception we would have to look back into the past of the sun, all values even become imaginary; that is to say, we lose the ground of reality entirely from under our feet. The physical experiment becomes an absurdity. Even the course of our clock becomes imaginary, yes, even time *in propria persona*, space, all processes, our organism, mankind,—in short the disease becomes incurable.

OBJECTS SHORTENED BY VELOCITY.

When the famous physicist of Leyden, Prof. H. A. Lorentz, advanced his incredible formula for an impossible behavior of light towards moving bodies, reality got beyond his control. But since his was a genuine Faust nature, it was easy enough for him to construct a handful of brilliant new laws of nature. The mathematical genius of Leyden created a "new" law for himself and a "new" world. Boldly and prudently he advanced a proposition which contradicts the law of inertia so laboriously attained: *Bodies which move through space with a velocity are diminished in the direction of their velocity*, computed only in the direction of their motion. What a phenomenal labor it required to diminish an earthly body, for instance bars of porphyry and steel, only $\frac{1}{200000}$ of its length, Lorentz did not take into consideration. He worked a charm contrary to the dictum of all renowned conjurers who must know better, namely, that legerdemain is not magic.

That such a shortening—it is called after its gifted originator a Lorentz-contraction—nevertheless must obviously possess a most profound energetic significance, that it operates in its consequences upon the surrounding universe to the most remote stars, that it must transform our entire world-conception—these points the master has wisely passed over in silence.

To be sure this wonderful law would be of great practical value. For instance it would no longer be necessary to send fat people to Marienbad to partake of its bubbling waters and to torment themselves with constitutionals by the hour. They would need simply to stand daily for an hour at a time with their bodies in the direction of the earth's motion. Because of the earth's velocity their bodies must needs experience Lorentz-contractions and become thinner, and this by means of the power of the beneficent new laws of nature.

Yes, let us say it with ruthless plainness. We must not let the earth too greatly exceed its alleged velocity of 30 kilometers, nor must we allow her ever so to forget herself as to assume a velocity of 300,000 kilometers, for then it would be all over with us. The Lorentz-contractions would no longer be child's play. We would become quite flat. Indeed flat is no name for it! No, we would be infinitely thinner than flat; for since the dimension of the earth would contract to nothing—absolutely nothing—in the direction of its motion, then in this extreme case it would become only a circular disk like the paper hoops which the circus clown holds before the leaping equestrienne on her dapple gray horse. Only this hoop would be infinitely superior in strength to the flattened earth, for it is of the tangible thickness of paper, whereas the thickness of the earth would be 0, nothing. All dimensions of the earth in other directions would remain the same in their original extension. Hence it would have merely a circumference, it would be a flat disk without thickness, a bodiless body, a breath! A scheme, a concept! So much can a planet be reduced when it assumes velocities which approach the velocity of light—and when at the same time it falls into the hands of famous mathematicians....

But what if the velocity of the earth exceeded even that of light? If it traveled at a rate of 350,000 or 400,000 kilometers per second, which of course might actually be so, though if it were we would not be able to find it out. Would it then have a minus thickness? What would a minus thickness look like? No, according to the formula it attains an *imaginary* thickness, but it always

continues to be *really* broad, high and round; only in its thickness, (i. e., in the direction of the motion) is it *imaginary*.

That would indeed be a sublime thought! By spinning out this idea I could, if I thought it necessary, obtain not only the friendship but also the admiration of the relativity physicists who are to-day in the lead. They would erect bronze monuments to me while still in the flesh.

[However, there are some differences of opinion. Leo Gilbert continues in the next chapter, saying that everything is mere appearance. He says:]

The fat men have congratulated themselves too soon. Unfortunately the Lorentz-contractions are ineffective. For, sorry to say, Prof. K. A. Einstein in Zurich, the most thoughtful of the mathematical prestidigitators, has deprived us of this new benefaction, and so has rescued Marienbad from desolation. Let no one who stands with his body in the direction of the earth's velocity be persuaded that it really is reduced. The reduction is only apparent. But in appearance, in imagination, the phenomenon positively takes place!

MINKOWSKI ON TIME.

[Formerly we thought that time is absolute in the sense that the present moment is everywhere. It is the ever-present Now which is in the same way here and there, on earth, on the sun, on the star Sirius and on the most distant sun in the universe. But Minkowski teaches us something better and grander; he says time is relative. Mr. Gilbert continues:]

It is asking altogether too much of the ordinary human intellect, but there can no longer be any doubt about it,—now is no longer now, day before yesterday is no longer day before yesterday. But yesterday is to-morrow, the future is past, and to-day is nevermore! The relativity of time! Delightful word! Intoxicating term! If it only had some sense! The late Hermann Minkowski is said to have been a very eminent, some say from hearsay an "ingenious," mathematician. This is sufficient to account for the high respect which his colleagues render to a talent in which Minkowski was absolutely lacking, namely the interpretation of natural phenomena. He lacked every suggestion of a trace of ability to touch creatively the philosophy of nature or the theory of cognition. A professor of mechanics in a technical high school in Germany once recommended to me the ingenious lecture of Minkowski on

time and space, and added, "which unfortunately is hard to understand." A funny recommendation of something which can not be easily understood, hence may even be false. I believe indeed that the lecture is obscure enough for many professors of mathematics, and it is only from this haziness that we can understand that the gentlemen of the eightieth congress of naturalists at Cologne dissolved in admiration before the splendid intellect of Minkowski. The uncomprehended has always been the greatest religious mystery before which mankind has bowed. If you wish to be successful be obscure, be unintelligible. Especially for naturalists! particularly for exact scientists! and most of all for mathematicians!...

I at once wrote back in reply to the excellent professor of mechanics that unfortunately the lecture was only too intelligible to me since I had been engaged on the subject for twenty years, and that I had perceived nothing in it more clearly than a certain childish guilelessness with which Minkowski had passed by the little that had already been said about time and space by better thinkers....

[If he had studied into the matter] it would have been impossible for him to have combined all the fabulous absurdities which could find comprehension in that wonderfully constructed brain, in which a medley of numbers, physics and Kant, dance around in confusion.... Minkowski tells us: "From now on space-in-itself and time-in-itself sink entirely into shadows and only a sort of union of the two can retain independent existence." Of course this childish poetry about the "sinking shadows" which brings to mind school memories of Homer and Dante is wonderfully affecting to the hearts of mathematical physicists, so that many hasten to quote this remarkable phrase of "a sort of union" in their publications.

Moreover Minkowski has made the most surprising discovery that time is not the same time everywhere. We poor inferior people had hitherto believed that the present moment which we now experience on earth is identical with the present moment in the most remote finitenesses. In short, that time is absolute, rigorously absolute, as rigorous as the most rigid of all the laws of nature.

Oh, fudge! Minkowski and Einstein now inform us that even time is relative. When our clock upon the earth strikes twelve, on another star in another system of planets it may be striking three quarters of an hour and five seconds after twenty-six, or even thirteen hundred and seven. The simultaneousness of events, that

powerful controlling law which alone makes possible a thought, a comparison, a demonstration, a knowledge—the law of the absolute simultaneousness of the infinitely small differential of the moment which divides the past from the future by a hair, and which we call the present—this iron law of reason is simply abolished by an overrational professor in the midst of the acclamations of other professors.

“No hour strikes for the happy man”—especially at the beer table of the naturalist congress when the gentlemen have done joyful justice to the enlightening beverage....

In their liberality with senseless contentions the relativists are downright spendthrifts. One reads in Minkowski the subtle clairvoyant assertion that there are several cosmic spaces. “Several cosmic spaces!” This remarkable mode of thought and speech has already found its quotation fiends, for there is no folly which does not arouse some scholar, or author, or journalist, by the fascination which lurks in paradoxes, to dish up the affair scalding hot. “Several cosmic spaces!!!” How very amusing!! What can separate them from each other? Cardboard walls? Or strong leaded glass? Probably plate glass, because otherwise the ray of light upon which the whole relativity bluff is based could not shine through from one cosmic space to the other. Or perhaps the partition walls are made of thickened ether? Or baked electricity? Or dried formulas and watered scholars’ prattle?

Among the people who have fallen into the trap of the Messrs. Relativists with particular *élan* and *chic* is to be mentioned Geheimrat Dr. Max Planck, professor at the University of Berlin. In an essay which appeared in the *Umschau* of October 29, 1910, and which bore the pompous title, “The Position of Modern Physics with Relation to Phenomenal Nature,” even he quotes admiringly Minkowski’s bold phrase [with reference to time and space] about the shadows and the union. He finds that the principle of relativity leads “to a very far-reaching—one might almost say revolutionary—consequence with reference to the conception of time,” “since a proposition with regard to time does not contain a physical sense until the observer’s state of velocity to which it refers is taken into account....”

Referring to Minkowski, Planck closes: “Accordingly the physical world accessible to our observations possesses four equally justified interchangeable dimensions, three of which we call space and the fourth, time.”

EDITORIAL CONCLUSION.

Much may be said in reply to Mr. Leo Gilbert's satire; how here and there he slightly twists the propositions of the inventors of the principle of relativity, and how in his exuberant humor he draws consequences which they would not countenance; indeed some of them are actually disavowed. Relativists will probably remind him that according to their claim the velocity of light is the greatest possible velocity, which would cut out some of the best and most humorous comments he makes. Yet we must grant him that no valid reason for this assertion of a truly absolutistic nature has as yet been produced. We feel tempted to make further comments as to what may be said in favor of the new doctrine of the principle of relativity and the half-truths it contains, but we prefer to give the relativists an opportunity to take the stand themselves, although they will probably meet this new attack with complaints that they have been misunderstood and that it is not worth their while to given an answer. To kill with silence (or as the Germans say *Totschweigen*) is the safest mode of defence for a weak cause. Mr. Gilbert claims that this is invariably the method of the relativists, and so for his motto he places on the title page of his book the conjugation of the verb, which he calls the "chorus of the craft":

"Ich schweige tot,
Du schweigst tot,
Er schweigt tot,
Wir schweigen tot,
Ihr schweigt tot,
Sie schweigen tot."

In brief we do not endorse all the conclusions of Mr. Gilbert's criticisms, but we deem his book worth a perusal and a careful reply. The mere humor of it will richly repay the reader for the hour spent thereon.

P. C.

EDUARD STUDY'S REALISTIC WORLD-CONCEPTION.

Eduard Study, professor of mathematics in Bonn, has published an essay on "The Realistic World-Conception and the Theory of Space."¹ The task before him is thus formulated on page 62:

"In what consists the epistemological value of the geometrical

¹ *Die realistische Weltansicht und die Lehre vom Raume.* Brunswick. F. Vieweg & Sohn, 1914.